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(54) Ink pen assembly

(57) An ink pen assembly (10) of a continuous ink jet printer includes a printhead nest and an ink pen cartridge (14) removably received within the nest. The cartridge includes a pen body (30) in electrical communication with the printhead nest, and a nozzle body (40) in fluid communication with the printhead nest. A charge electrode charges ink drops breaking off from ink jetted from an outlet of the nozzle body. A deflection electrode deflects the charged ink drops along an axis substantially transverse to a direction of travel of a substrate being printed. An ink block mount includes an ink blocking element for diverting deflected ink drops. An ink block actuator pivots with respect to the pen body to adjust the position of the ink blocking element. The printhead nest defines at least four ink outlets for delivering different colored inks, and at least four ink pen cartridges are removably received by the printhead nest.

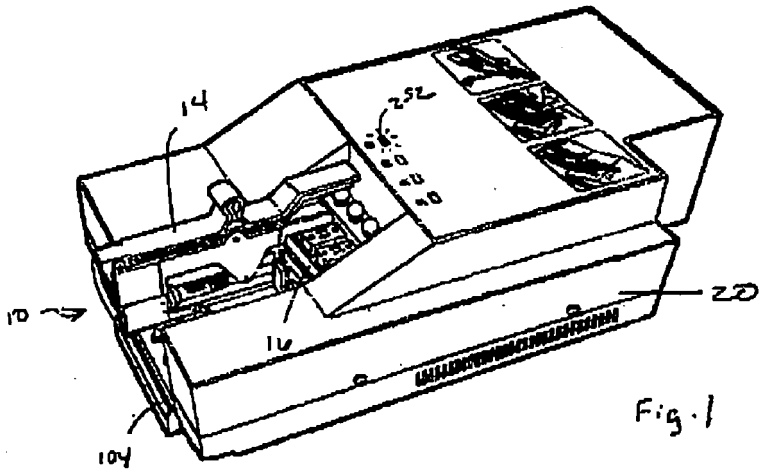

Fig. 1

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[0021] Embodiments of this aspect of the invention may includes one or are of the following features.

[0022] A fluid catcher receives ink that drains from the ink pen cartridge. The housing defines four ink outlets, four mechanical links, and four electrical connections. The ink outlets provide ink to four ink pen cartridge. The mechanical links and electrical connections each interface with one of the four ink pen cartridges.

[0023] According to another aspect of the invention, an ink pen assembly includes and ink pen cartridge and a printhead nest. The ink pen cartridge includes a pen body, a nozzle body, a charge electrode, and a deflection electrode. The printhead nest includes a housing defining an ink outlet for providing ink to an inlet of the nozzle body, and an electrical connection for interfacing with the pen body to control the charge tunnel and deflection electrodes. The ink pen is configured for placement in the printhead nest and removal from the printhead nest as a single unit.

[0024] According to another aspect of the invention a continuous ink jet printer includes a printhead nest defining at least four ink outlets. The printhead nest is configured to deliver a different colored ink through each of four ink outlets. At least four ink pen cartridges are removably received by the printhead neat. Each ink pen cartridge defines an ink inlet aligned with one of the ink outlets for receiving ink from the printhead neat when the ink pen cartridges are received by the printhead nest. Each ink pen cartridge also includes a charge electrode for charging ink drops breaking off from the received ink, and a deflection electrode for deflecting charged ink drops. Each deflection electrode is configured and arranged such that charged ink drops are deflected along an axis substantially transverse to a direction of travel of a substrate to be printed. The charge electrode is adjustable to impart varying levels of charge to the ink drops such that different ink drops are deflected by different amounts by the deflection electrode to facilitate registration of the ink drops from the at least four ink pen cartridges on a substrate.

[0025] Advantages of the invention includes a disposable ink pen cartridge which includes all of the components of a continuous ink jet printhead, e.g., the drop producing, drop charging, and drop deflecting elements, which are likely to fail. The ink pen cartridge can be quickly removed and disposed of and replaced with a new cartridge. The failed cartridge can be replaced even while the continuous ink jet printer remains turned on.

[0026] Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

Brief Description of the Drawings

[0027]

Fig. 1 is a schematic illustration of an ink pen assembly of the invention;

Fig. 2 is a perspective view of an ink pen cartridge of the assembly of Fig. 1;

Fig. 3A is an exploded view of the ink pen cartridge of Fig. 2;

Fig. 3B is a side view of a knife edge of the ink pen cartridge of Fig. 2;

Fig. 4A shows a pen body of the ink pen cartridge of Fig. 2 with a side of the pen body removed;

Fig. 4B is a partial bottom view of the pen body of Fig. 4A;

Fig. 5A is a top view of a nozzle body of the ink pen cartridge of Fig. 2;

Fig. 5B is a cross-sectional side view of the nozzle body of Fig. 5A;

Fig. 6A is a top view of the assembly of Fig. 1 shown during printing on a substrate;

Fig. 6B is a side view of the assembly of Fig. 1 shown during printing on the substrate;

Fig. 7 is an illustration of a pen electronics board assembly of the ink pen assembly of Fig. 1, shown mounted to a continuous ink jet printer;

Fig. 8 is a cross-sectional side view showing the interface of the ink pen cartridge of Fig. 2 with a printhead nest of the pen electronics board assembly of Fig. 7; and

Fig. 9 illustrates a priming pen being mounted to the printhead nest.

Description of the Preferred Embodiment

[0028] Referring to Fig. 1, an ink pen assembly 10 of a continuous ink jet printer includes a printhead nest 16 and up to four disposable ink pen cartridges 14, one cartridge being shown in Fig. 1, received by nest 16. Nest 16 is a component of a pen electronics board assembly 20 mounted to move along a lead screw 22 (Figs. 6B and 7) of the printer. Each ink pen preferably deliveries a different color ink to a substrate to produce a multi-color image on the substrate, as described, e.g., in Ingraham et al., U.S. Patent No. 5,416,612, incorporated by reference herein. When an ink pen becomes clogged or otherwise reaches the end of its useful service life, the ink pen can be removed from the nest and replaced with a new ink pen.

[0029] Referring to Figs. 2 and 3A, ink pen cartridge 14 includes a pen body 30 and a nozzle body 40. Nozzle body 40 is mounted to pen body 30 with pins 62, 64 which pass through mounting holes 32, 34 in pen body 30 and corresponding mounting holes 42, 44 in nozzle body 40. An ink block actuator, e.g., knife edge arm 50, is mounted to pen body 30 to pivot about a pivot pin 66 received in mounting holes 36 of pen body 30. A finger grip 54 of arm 50 provides an easy means for the user to grasp ink pen 14 for insertion and removal from nest 16.

[0030] Referring to Figs. 3A, 4A and 4B, housed within an electrode mounting section 70 of pen body 30 is a

sage 170. A second o-ring cavity 172 located at a vacuum inlet 130a in end face 135 of the nozzle body houses an o-ring 174. O-ring 174 provides a seal with nest 16, described further below. An outlet 176 of vacuum passage 179 communicates with the distal end of the tube through region 178 surrounding nozzle 146 and channel 180 defined between end cap 148 and nozzle 146. Cleaning fluid can be pumped into chamber 93 through vacuum passage 170.

[0042] An o-ring cover 188 (Fig. 2) is provided to retain o-rings 136, 174 in o-ring cavities 134, 172, respectively, prior to positioning of the ink pen in the printhead nest. O-ring cover 188 includes a t-slot 189 which fits over a nozzle body lip 121.

[0043] Beside having ink and vacuum communication with nest 16, ink pen 14 is also in electrical and mechanical connection with nest 16. Referring to Fig. 3A, mounted to an underside 200 of ink pen body 30 is an electrical connection board 202. Board 202 includes electrical contacts 204 which interface with nest 16 to provide signals to transducer 140, charge tunnel 72, and electrodes 74, 76, as described further below.

[0044] To register ink drops in print processing of color images, as described, e.g., in Ingraham et al., supra, the charge applied to the printing ink drops by the charge tunnel is varied to adjust the deflection of the printing ink drops in a direction transverse to the direction of travel of the substrate. Referring to Figs. 6A and 6B, electrodes 74, 76 are oriented with respect to the direction of travel of the substrate (along arrow A) such that the electrodes deflect the ink drops along arrow B, oriented in a direction transverse to substrate travel and in the direction of travel of ink pen assembly 10. This results in a trajectory of the ink drop along arrow C. To accommodate changes in the charge of the printing drops, the knife edge is moved by adjusting the position of the knife edge arm, as described below, to insure that non-printing drops hit the knife edge while the printing drops pass by the knife edge.

[0045] Registration of four ink colors delivered by the four ink pens is performed by adjusting the charge applied to the printing ink drops by the charge tunnel (by varying the voltage applied to the charge tunnel), and by adjusting the pixel locations in the direction of substrate travel, as described in Ingraham et al., supra.

[0046] Referring to Figs. 7 and 8, nest 16 includes five partitions 220 defining four ink pen receiving t-slots 222. Lip 221 (Fig. 3A) of nozzle body 40 slides into t-slot 222 to connect nozzle body 40 to nest 16. Nest 16 also includes four pins 240. Guide 79 of ink pen cap 100 is received over a respective pin 240 to help align the ink pen with the nest. In a back wall 224 of each slot 222 in an ink outlet 230 and a vacuum outlet 232. With an ink-pen 14 positioned in t-slot 222, ink outlet 230 is in fluid communication with ink passage 120 of nozzle body 40, and vacuum outlet 232 is in fluid communication with vacuum passage 170 of nozzle body 40. O-rings 136, 174 provide seals between wall 224 of nest 16 and end face 135 of nozzle body 40.

[0047] To provide an electrical connection between nest 16 and the ink pens, nest 16 includes four electrical contact regions 250. With ink pen 14 positioned in nest 16, contacts 204 of board 202 interface with contact region 250. Each contact region 250 includes six contact points: a 2000 volt power supply; a charge tunnel charge level signal for adjusting the charge imparted to the ink drops by the charge tunnel; a 1 MHz stimulation voltage to the transducer; an ink pen ground; an ink pen sensor; and a primer fixture (described below) sensor. The ink pen sensor and primer fixture sensor sense when an ink pen or the primer fixture are in place in the nest. LEDs 252 (Fig. 1) signal when an ink pen or the primer fixture is in position in the nest.

[0048] Nest 16 also includes motor actuated, knife edge positioning pins 260. Each pin 260 contacts an undersurface 210 of arm 50. Raising and lowering of pin 260 causes arm 50 to pivot about its pivot point, thus adjusting the vertical position of knife edge 94.

[0049] An ink pen is inserted into nest 16 simply by grasping finger grip 54 and sliding lip 221 of nozzle body 14 into slot 222. When an ink pen needs to be replaced, the individual ink pen is removed from nest 16 simply by pulling up on finger grip 54. The ink pen is hot swapable, i.e., the power to the ink jet printer can be left on when an ink pen is removed from the nest and a new ink pen inserted into the nest. The ink pen sensing contact of the nest detects when the ink pen has been removed and shuts down dangerous voltages until the new ink pen is inserted.

[0050] Referring to Fig. 9, to prime the system, a priming pen 300 is provided. Pen 300 includes four slots 302 which are received within t-slots 222. Pen 300 includes four electrical contacts 304 which interface with contact region 250 to provide a signal indicating that the priming pen is in position in nest 16.

[0051] Other embodiments are within the scope of the following claims.

[0052] For example, the nest can be configured to accept more than four ink pens. Right ink pens would permit color printing twice as fast as with four ink pens, would allow the use of high and low density colors to expand the color range, and would also permit additional colors to be used while printing.

Claims

1. An ink pen cartridge removably received within a printhead nest of a continuous ink jet printer, comprising:

   a pen body configured to be placed in electrical communication with the printhead nest,

   a nozzle body connected to the pen body, the nozzle body defining an inlet configured to be placed in fluid communication with the printhead nest to receive ink from the printhead

17. The ink jet nozzle of claim 15 further comprising a transducer mounted to the tube for synchronizing breakup of a jet of ink from the tube outlet into ink drops.

18. The ink jet nozzle of claim 17 further comprising a first spring abutting the transducer on an upstream side of the transducer, and a second spring abutting the transducer on a downstream side of the transducer, the first and second springs locating the transducer with respect to the tube prior to fixing the transducer to the tube.

19. The ink jet nozzle of claim 18 wherein the second spring is connected to a ground plane of the transducer to act as a shield.

20. The ink jet nozzle of claim 15 wherein the tube comprises a capillary tube having an inner diameter of about 100 microns, the inner diameter being reduced to about 10 microns at the outlet end of the tube.

21. The ink jet nozzle of claim 15 further comprising a filter located at the inlet end of the tube.

22. A printhead nest for receiving an ink pen cartridge, comprising:

a housing defining an ink outlet for providing ink to the ink pen cartridge,
a mechanical link for interfacing with the ink pen cartridge to adjust the position of an ink blocking element of the ink pen cartridge, and
an electrical connection for interfacing with the ink pen cartridge to control a deflection electrode of the ink pen cartridge.

23. The printhead nest of claim 22 further comprising a fluid catcher for receiving ink that drains from the ink pen cartridge.

24. The printhead nest of claim 22 further comprising four ink outlets defined by the housing, each ink outlet for providing ink to one of four ink pen cartridge, four mechanical links, each mechanical link for interfacing with one of the four ink pen cartridges, and four electrical connections, each electrical connection for interfacing with one of the four ink pen cartridges.

25. An ink pen assembly, comprising:

ink pen cartridge and a printhead nest,
the ink pen cartridge including

a pen body configured to be placed in electrical communication with the printhead nest,
a nozzle body connected to the pen body, the nozzle body defining an inlet configured to be placed in fluid communication with the nest structure to receive ink from the neat structure, the nozzle body further defining an outlet through which ink is jetted,
a charge electrode connected to the pen body for charging ink drops breaking off from the ink jetted from the nozzle body outlet, and
a deflection electrode connected to the pen body for deflecting charged ink drops, the deflection electrode being configured and arranged such that charged ink drops are deflected along an axis generally transverse to a direction of travel of a substrate to be printed,

the printhead nest including

a housing defining an ink outlet for providing ink to the nozzle body inlet, and
an electrical connection for interfacing with the pen body to control the charge tunnel and deflection electrodes,

the ink pen being configured for placement in the printhead nest and removal from the printhead nest as a single unit.

26. A continuous ink jet printer, comprising:

a printhead nest defining at least four ink outlets, the printhead nest being configured to deliver a different colored ink through each of four ink outlets,
at least four ink pen cartridges removably received by the printhead nest,

each ink pen cartridge defining an ink inlet, each ink inlet being aligned with one of the ink outlets for receiving ink from the printhead nest when the ink pen cartridges are received by the printhead nest,
each ink pen cartridge including a charge electrode for charging ink drops breaking off from the received ink, and a deflection electrode for deflecting charged ink drops, each deflection electrode being configured and arranged such that charged ink drops are deflected along an axis substantially transverse to a direction of travel of a substrate to be printed, the charge electrode being adjustable to impart varying levels of charge to the ink drops such that different ink drops are deflected by different

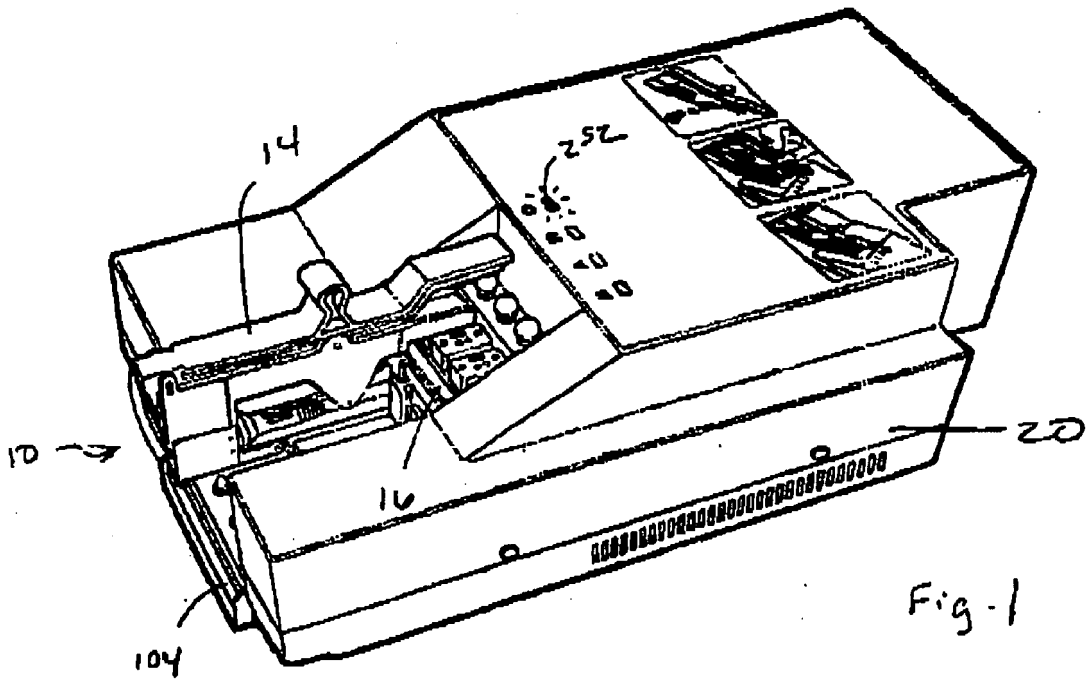

Fig. 1

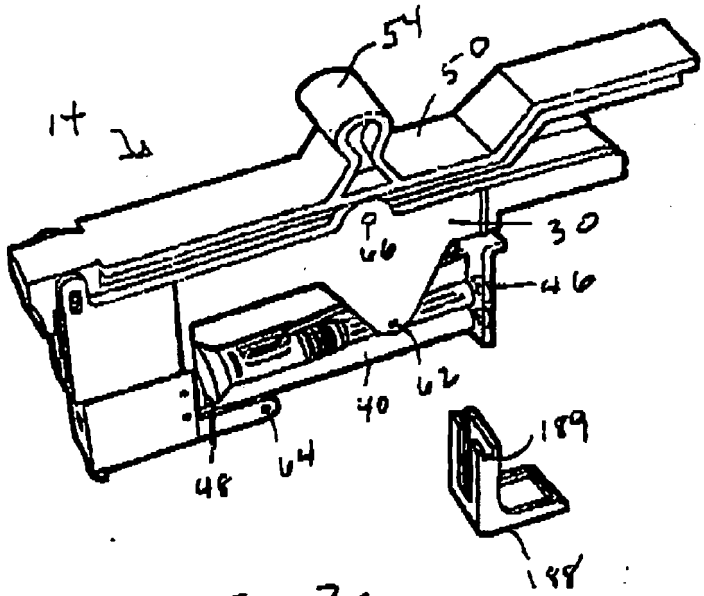

Fig. 2

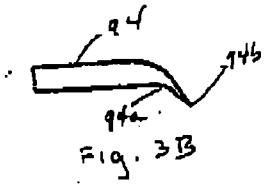

Fig. 3B

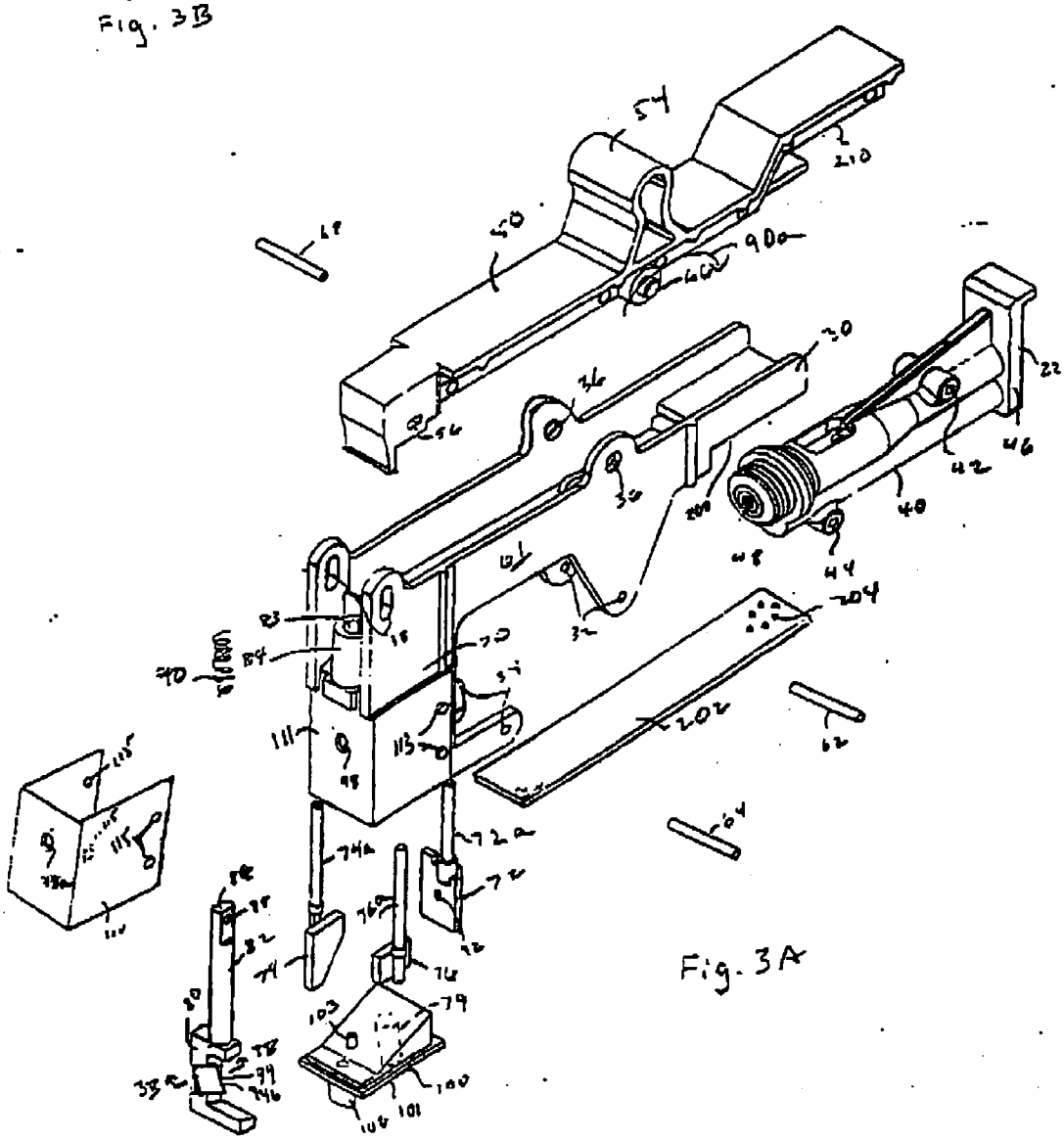

Fig. 3A

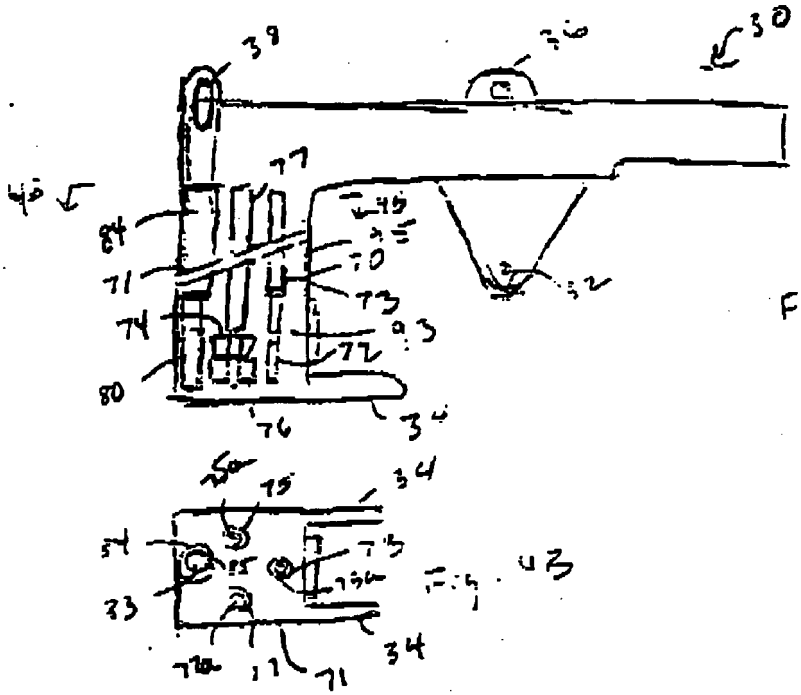

Fig. 4A

Fig. 4B

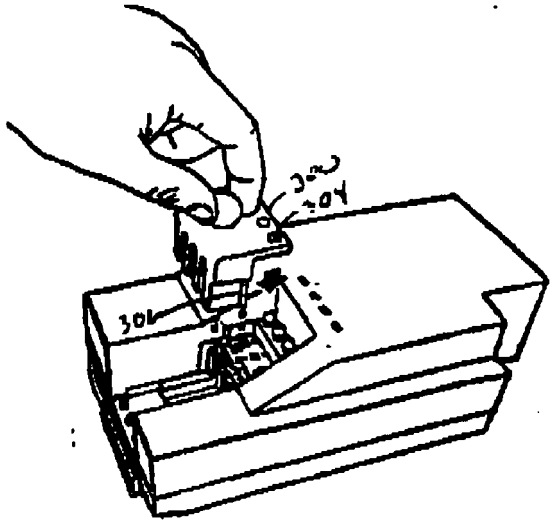

Fig. 9

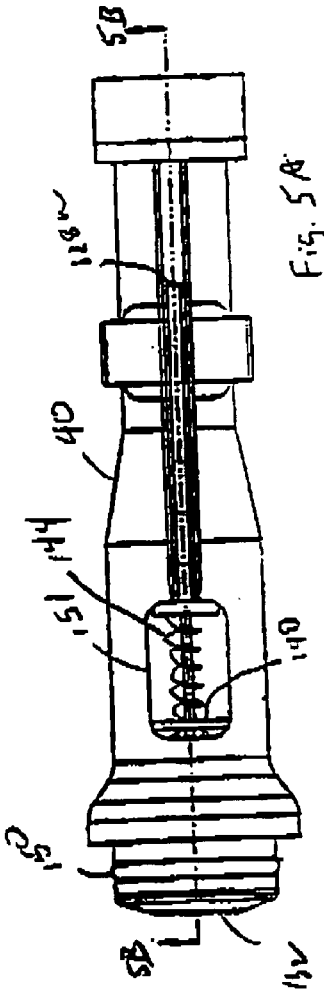

Fig. 5A

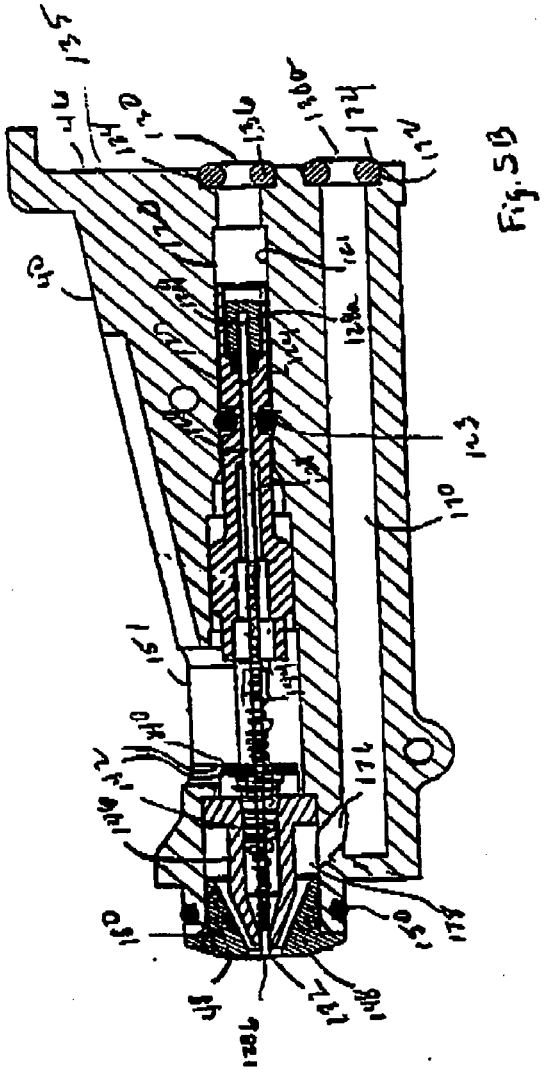

Fig. 5B

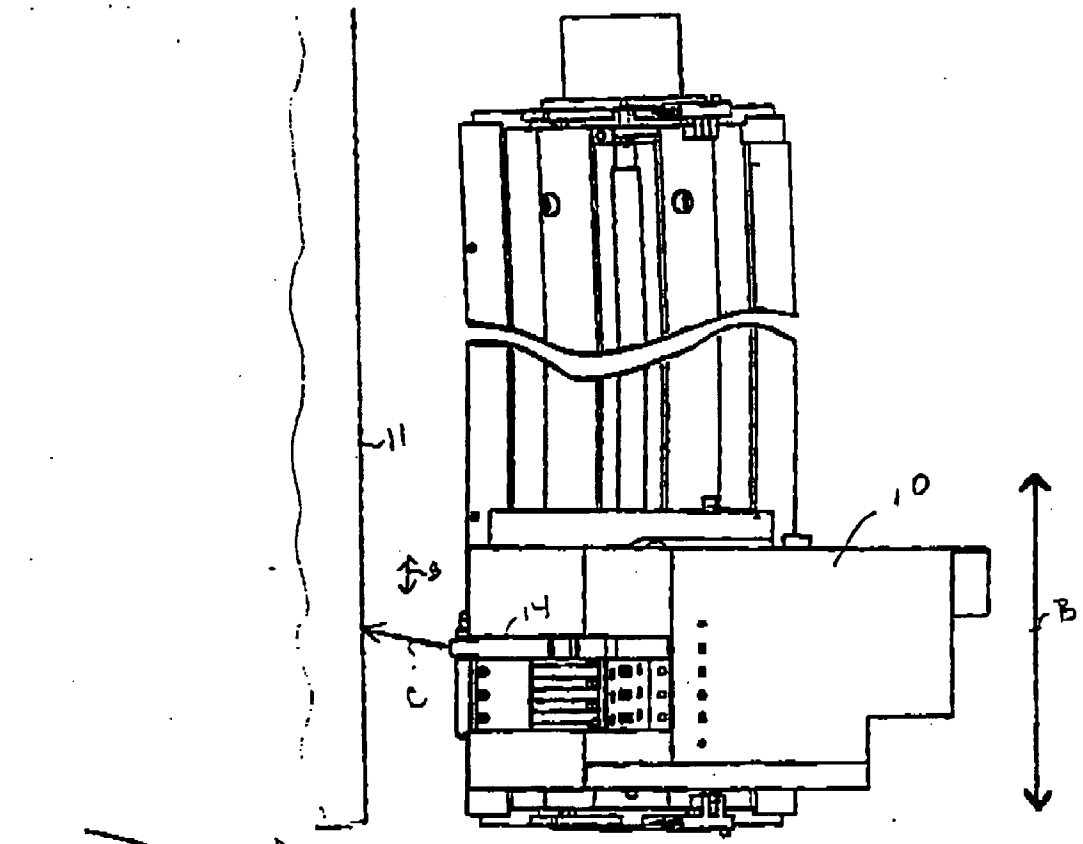

Fig. 6A

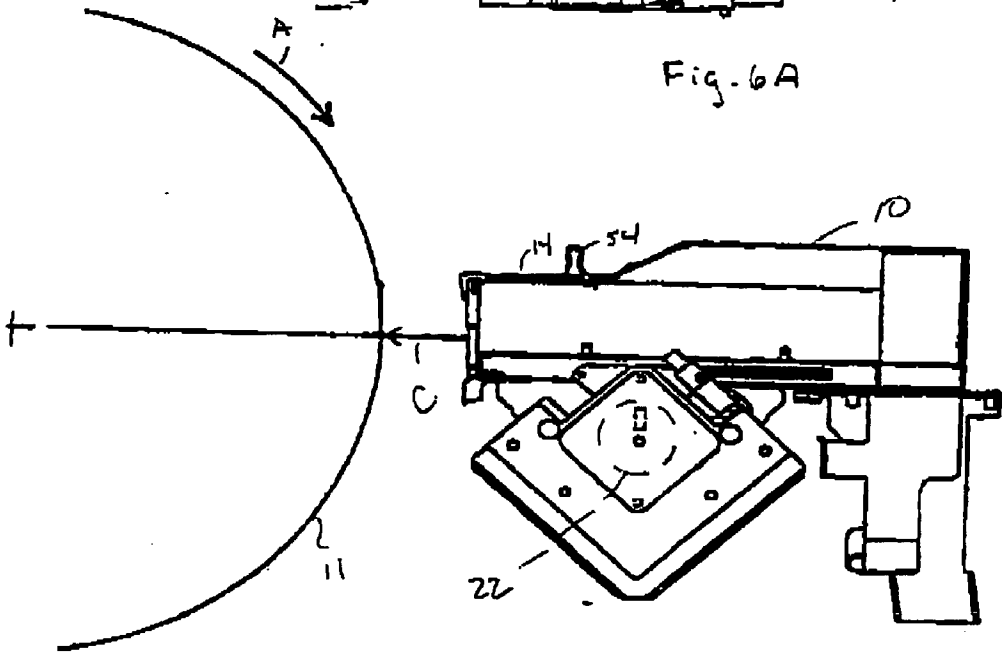

Fig. 6B

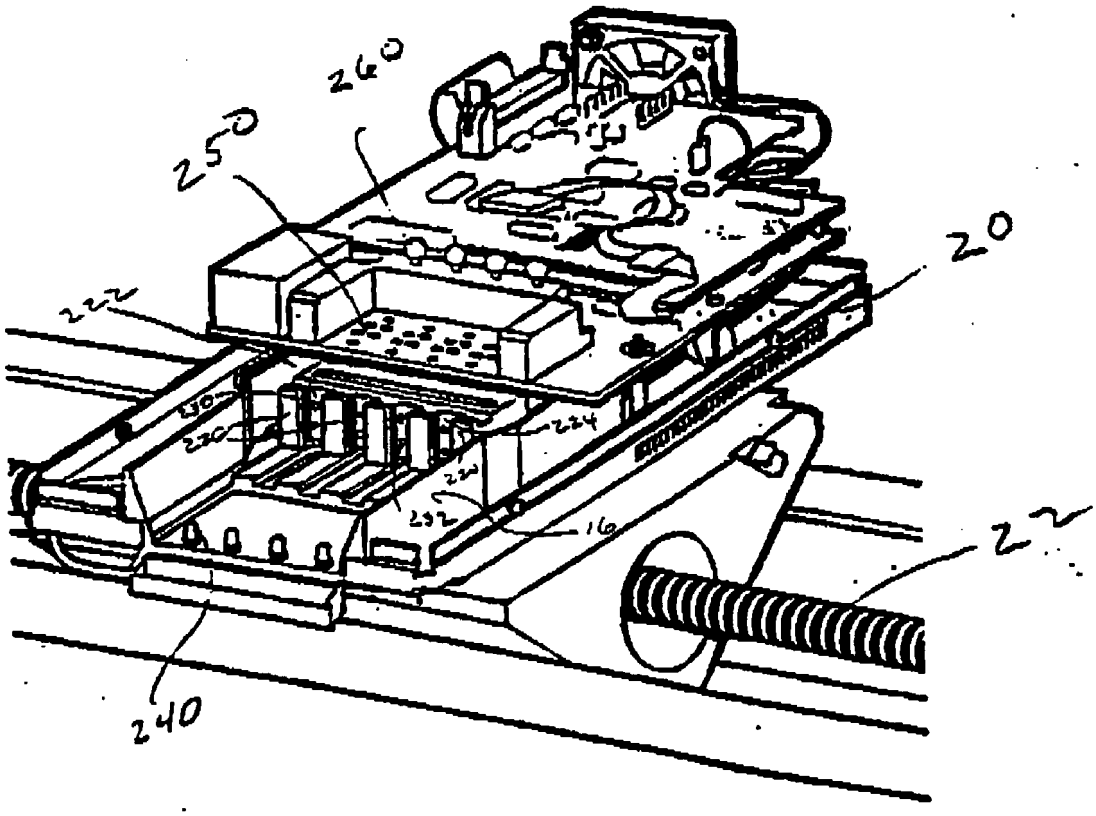

Fig. 7

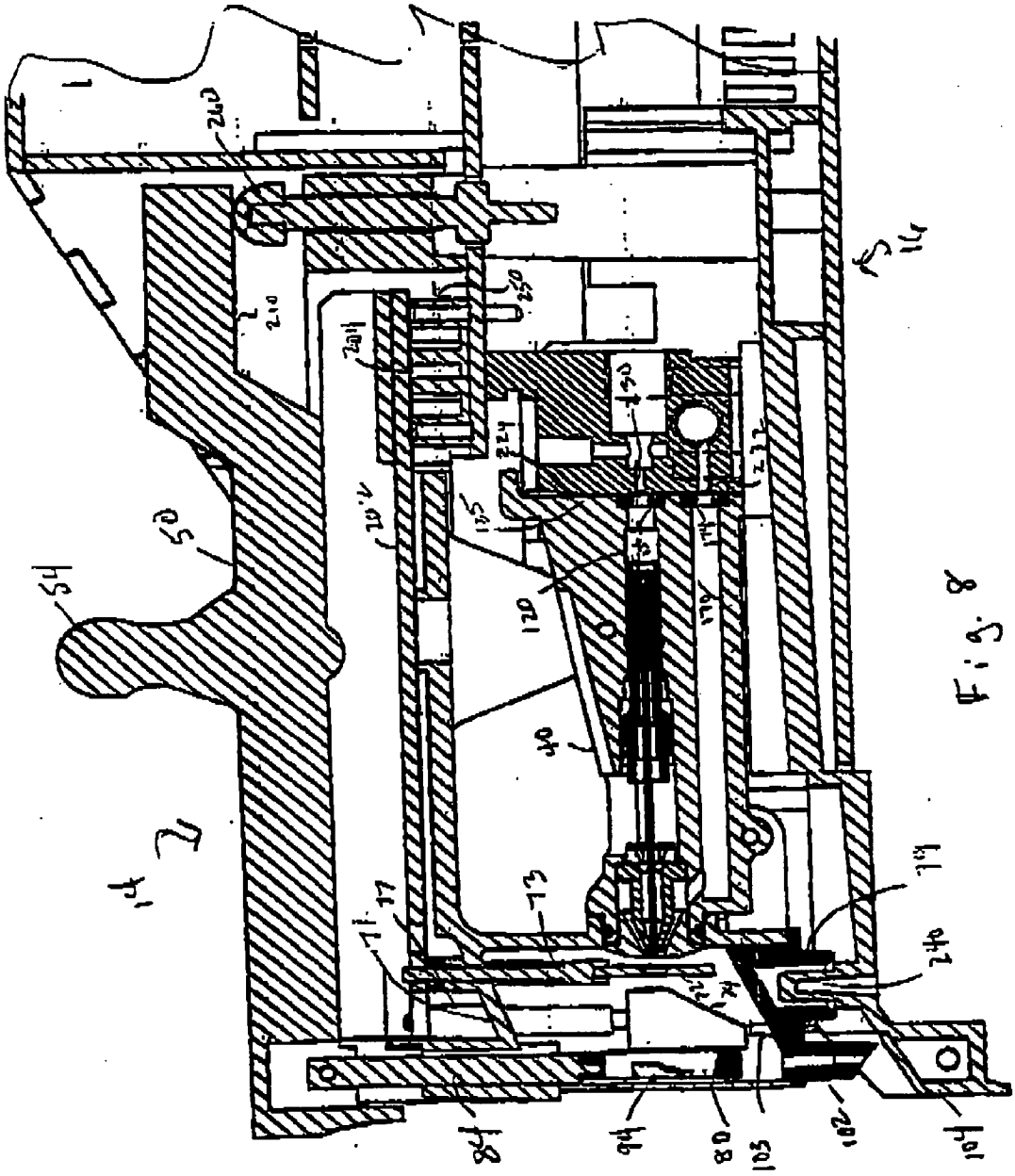

Fig. 8